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UNIQUE GEOLOGICAL, PALAEOBOTANICAL AND ARCHAEOLOGICAL SITE IN WITÓW NEAR BRZESKO NOWE (SOUTHERN POLAND)

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Abstract. The study area near village Witów situated about 50 kilometres north-east of the Kraków city is famous for its exposed deposits called the "Witów Series" on which palaeobotanical, micro- and macrofaunistic, malacological, sedimentological and petrographical studies have already been performed. From deposits of the Witów Series, plant macroremains belonging to gymnosperms and angiosperms were reported. *Pinus* cf. *palaeostrobus*, *Zelkova zelkovifolia* and *Spirematospermum wetzleri* are particularly interesting. Results of investigations on fossil plant remains point to the Late Miocene to Pliocene age of the Witów Series. Plant communities that existed in the vicinity of Witów could be compared to recent warm temperate and humid forests of the Colchis and Talysh Lowland in Transcaucasus and to forests of Central China. Presence of remains of termophilous taxa point to warmer climate of the period of sedimentation of the Witów Series than recent climate of Poland.

The Witów region is also famous for archaeological localities that has been known since the turn of the twentieth century. The site was being repeatedly settled beginning with the late Stone Age (the Neolithic Period). Traces of the most intensive periods of settlement come from the late Bronze and early Iron Ages (1000–600 BC) and are attributed to the so-called Lusatian culture. The site also yielded a medieval cemetery that can be dated to the turn of the twelfth century AD. This is the first confirmation of the presence of medieval settlements on this site. Location of Witów in the Vistula river valley may have allowed this settlement to control nearby routes and possibly river fords and also probably exercised political control over the surrounding areas. Considering scientific value of the Witów locality and necessity of their protection, creation of natural reserve on this area is suggested.

Key words: the Witów Series, plant macroremains, palaeovegetation, palaeoclimate, younger Neogene, archaeology, Małopolska, Witów.

Abstrakt. Stanowisko w Witowie, położone ok. 50 kilometrów na północny wschód od Krakowa, jest znane z odsłonięcia osadów określanych mianem serii witowskiej. Były one przedmiotem badań paleobotanicznych, paleozoologicznych, sedymentologicznych i petrograficznych. W osadach serii witowskiej znaleziono oznaczalne makroszczątki roślin iglastych i okrytozalążkowych. Szczególnie interesujące są kopalne gatunki *Pinus* cf. *palaeostrobus*, *Zelkova zelkovifolia* i *Spirematospermum wetzleri*. Wyniki badań szczątków roślinnych wskazują na późnomioceński lub plioceński wiek serii witowskiej. Kopalne zbiorowiska roślinne, które występowały w okolicy Witowa można porównać do współczesnych podzwrotnikowych lasów wilgotnych obszaru Kolchidy i Niziny Tałyskiej na Zakaukaziu oraz środkowych Chin. Obecność szczątków roślinności ciepłolubnej wskazuje na cieplejszy niż obecnie klimat okresu sedymentacji serii witowskiej.

Witów jest znany także ze stanowisk archeologicznych. Obszar ten od neolitu był wielokrotnie zasiedlany. Ślady najintensywniejszego osadnictwa pochodzą z końca epoki brązu i początków epoki żelaza (1000–600 BC) i są odnoszone do kultury łużyckiej. Na stanowisku w Witowie znaleziono także średniowieczny cmentarz datowany na koniec jedenastego wieku po Chrystusie, będący pierwszym dowodem na obecność średniowiecznego osadnictwa na tym terenie. Położenie Witowa na brzegu doliny Wisły zapewne dawało mu kontrolę nad okolicznymi szlakami oraz, być może, także nad brodami. Możliwe, że Witów sprawował także polityczną kontrolę na otaczających go terenach. Biorąc pod uwagę naukową wartość stanowiska w Witowie i wynikającą stąd konieczność jego ochrony, postulowane jest utworzenie na jego obszarze rezerwatu przyrody.

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Słowa kluczowe: seria witowska, makroszczątki roślinne, paleoroślinność, paleoklimat, młodszy neogen, archeologia, Małopolska, Witów.

The study area near village Witów is situated about 50 kilometres north-east of the Kraków city, on the escarpment of the Małopolska Upland bordering on Vistula river valley and Sandomierz Basin (Fig. 1). Rising over 70 m above the surrounding countryside, the rock spur located between the Vistula and Szreniawa river valleys dominates the landscape around Witów. The Witów region is famous for its exposed coarse-grained clastics — called the "Witów Series" which have been an object of great interest for geologists for more than fifty years (Łyczewska, 1948; Dżułyński *et al.*, 1968). There is a rich literature concerning these formations, in the order of several dozen positions. The exposed sediments, up to thirty meters thick, present an invaluable opportunity for conducting research. The following studies have already been performed onsite: palaeobotanical (micro- and macroremains of plants), micro- and macrofaunistical, malacological, sedimentological, and petrographical. The sediments were dated using the thermoluminescent method. Palaeomagnetical studies were also conducted. This location gives a unique opportunity for observing a whole range of tectonical phenomena in the coarse clastic series. The conclusions based on these studies differed, and dated the Witów Series as being formed anytime from the Sarmatian to the Nidanian Glaciation (Quaternary). Palaeobotanical studies of macroremains of plants that have been performed recently point to younger Neogene age (Brud, Worobiec, 2003).

Presence of numerous indeterminate plant macroremains in the deposits of the Witów Series at Witów have already been reported by earlier investigators (Dżułyński *et al.*, 1968). At the beginning of the 2002 year, in the lower part of the Witów Series outcrop for the first time macroremains of plants that could be determined were found. Plant macroremains were preserved as imprints only, often fragmentary. Besides macroremains suitable for investigations (mostly leaves), abundant

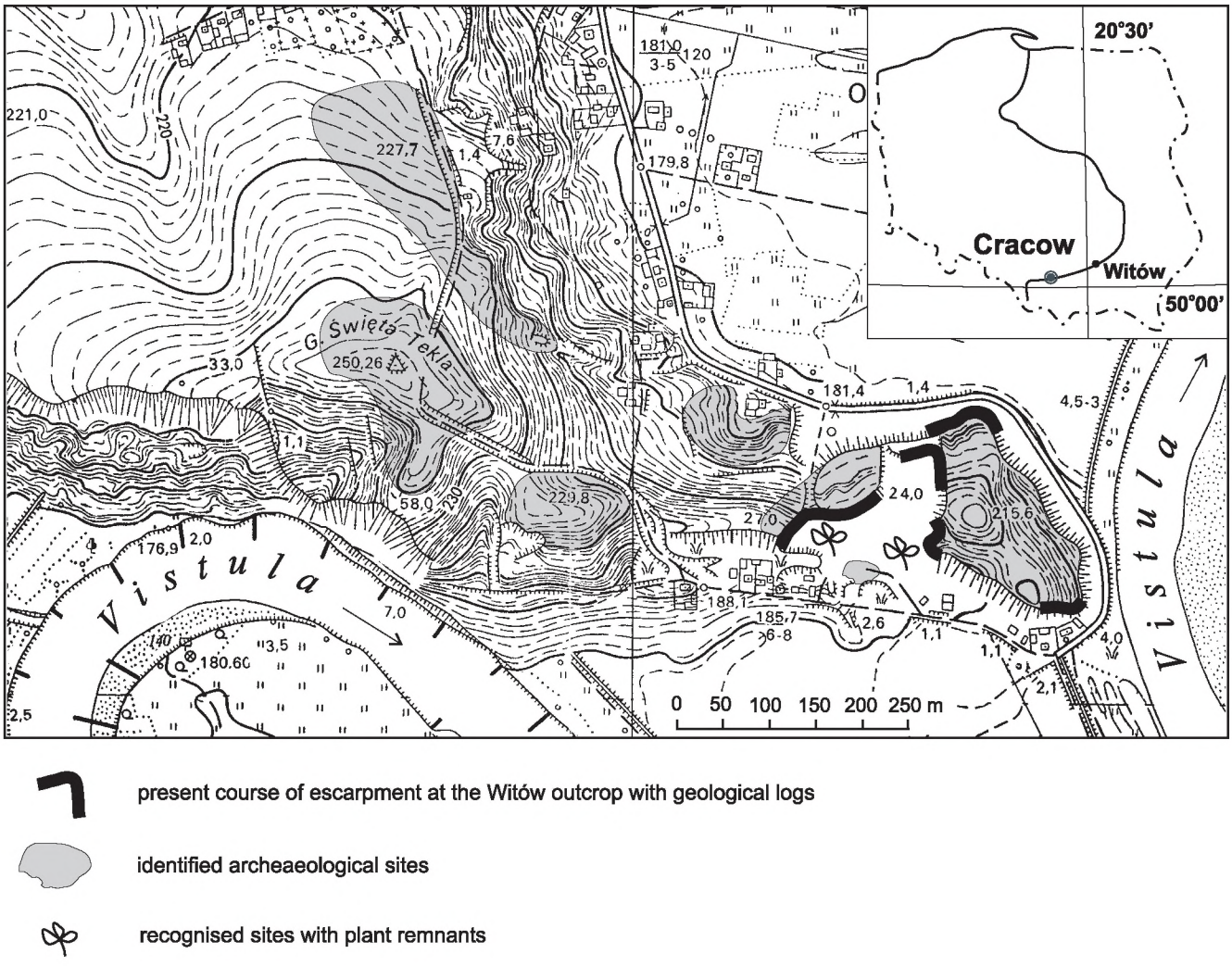

Fig. 1. Location of the studied area

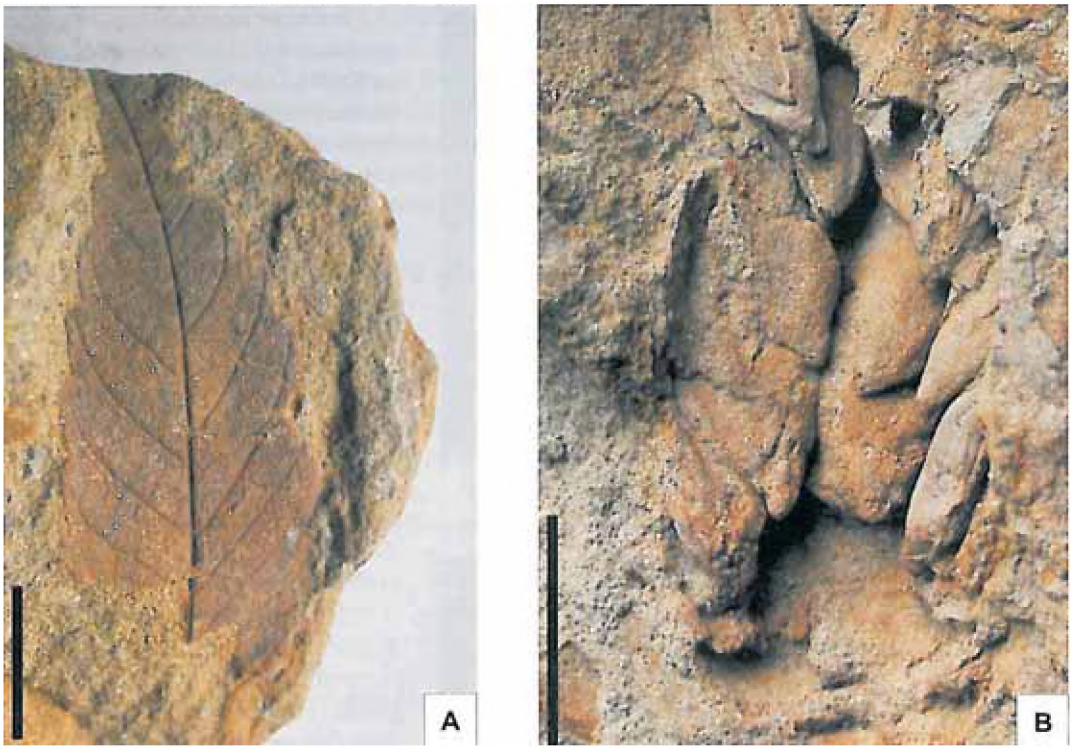

Fig. 2. A. *Zelkova zelkovifolia* (Unger) Bůžek et Kotlaba, leaf imprint, Witów, No. KRAM-P 239/D/4.
B. *Spirematospermum wetzleri* (Heer) Chandler, fragment of fruit with seeds, Witów, No. KRAM-P 239/C/36; scale bar = 1 cm

accumulations of indeterminate plant detritus in form of twigs, bark, coniferous needles, fragments of stems and rhizomes of herbaceous plants, and very rarely almost completely weathered remains of coalified cones were found.

From the investigated part of the Witów Series, macroremains of gymnosperms and angiosperms were reported. Gymnosperms are represented by imprints of branches with needles of fossil pine *Pinus* cf. *palaeostrobus* (Ettingshausen) Heer, and a few imprints of indeterminate remains of branches belonging most probably to several genera of coniferous trees. Leaves of fossil *Zelkova zelkovifolia* (Unger) Bůžek et Kotlaba (Fig. 2A), cottonwood (*Populus* sp.), beech (*Fagus* sp.) "*Leguminosae*" sensu Berger, and several indeterminate morphotypes of leaves, as well as fruit of *Juglans* L. vel *Carya* Nutt. represent angiosperms belonging to the Dicotyledones. Fragment of fruit with seeds of extinct *Spirematospermum wetzleri* (Heer) Chandler (Fig. 2B) and badly preserved leaf imprints belong to Monocotyledones.

Among the listed fossil plant taxa, the following are particularly interesting: *Pinus* cf. *palaeostrobus*, *Zelkova zelkovifolia* and *Spirematospermum wetzleri*. Fossil pine, *Pinus palaeostrobus*, is probably related to extant eastern white pine — *Pinus strobus* L. Eastern white pine grows today far away from Poland in forests of the north-eastern states of USA and Canada (Seneta, 1987). Besides Chłapowo (= Rozewie; Heer, 1869), Witów is the second locality of this fossil taxon in the Tertiary of Poland. Extant *Zelkova sinica* Schneid growing in mesophytic forests of China (Krüssmann, 1978) is closely related to fossil *Zelkova zelkovifolia* whose leaf imprints was found in the Witów Series. Extinct species *Spirematospermum wetzleri* is a representative of termophilous, exotic vegetation. Recent relatives of this fossil plant (genera *Cenolophon*, *Alpinia* and ginger — *Zingiber officinale* Roscoe), members of the gingers family (Zingiberaceae) occur exclusively in the subtropics and tropics today (Hutchinson, 1973).

On the basis of results of palaeobotanical investigations on fossil plant assemblages from the Witów Series, palaeofloristic and palaeoclimatic deductions can be done. Plant communities that existed in the vicinity of Witów could be compared to the recent forests of the Colchis and Talysh Lowland in Transcaucasus and to forests of Central China. This vegetation is placed in the group of warm temperate and humid forests with considerable admixture of evergreen taxa (Podbielkowski, 1991). Presence of *Spirematospermum wetzleri* fruit and remains of other termophilous taxa (*Juglans* vel *Carya* and *Zelkova*) point to warmer climate of the sedimentation period of the Witów Series than the recent climate of Poland. Mean annual temperature was considerably higher and could reach even +14°C. Winters were mild, and the lowest temperatures most probably did not fall below –5°C (Brud, Worobiec, 2003).

Results of fossil plant remains investigations were the basis of determination of the age and the stratigraphical position of the Witów Series as well. Presence of the *Spirematospermum wetzleri*, remains of which have been known in the fossil floras of Poland from Middle and Upper Miocene deposits (Zastawniak *et al.*, 1996), and outside Poland only infrequently from Pliocene, and presence of *Zelkova zelkovifolia* point to the Late Miocene to Pliocene age of the Witów Series.

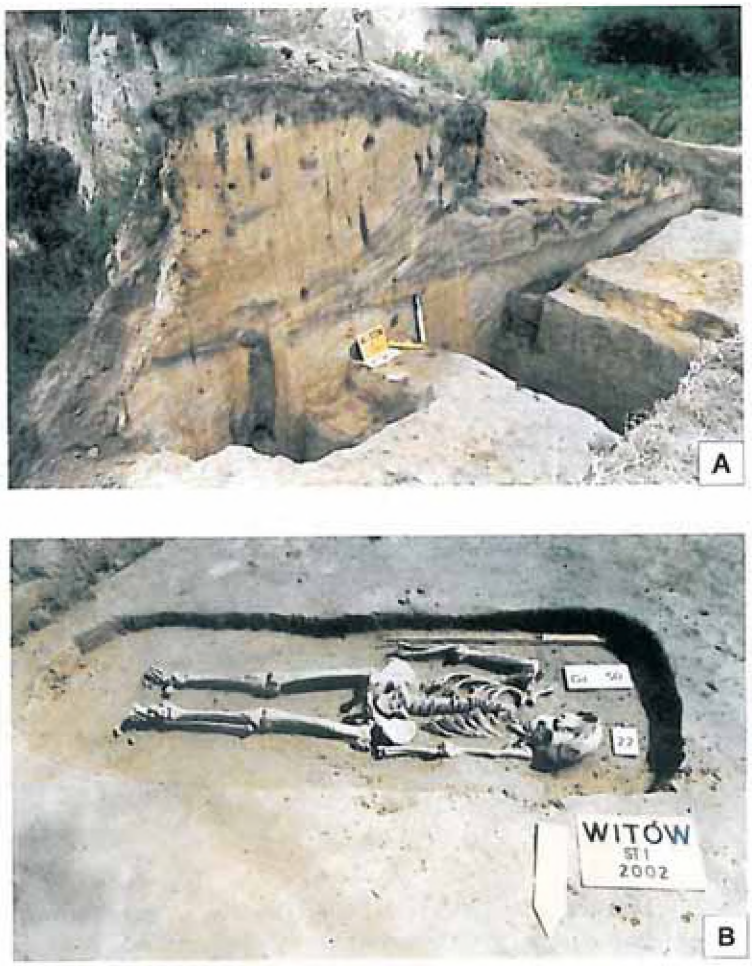

Fig. 3. A. Section of fortifications (sector III, part W). **B**. Medieval burial (grave 22)

The Witów region is also famous for its archaeological localities. The defensive and domicile advantages of this place had to be appreciated from the very beginning of this area's settlement process. The archaeological site at Witów has been known since the turn of the twentieth century. The spit and its surrounding countryside have then already yielded Bronze Age pottery fragments. The site was being repeatedly settled in earlier periods of prehistory as well, beginning with the late Stone Age (the Neolithic Period). Traces of the most intensive periods of settlement come from the late Bronze and early Iron Ages and are attributed to the so-called Lusatian culture (Marciniak, 1963, 1966). Without doubt, the most spectacular find connected with Witów is the discovery of a treasure of Roman gold coins — solidus (Kaczanowski, Kozłowski, 1998).

Due to the continuing deterioration of the site, the Małopolska Heritage Conservation Department took steps, in 2002, to conduct rescue excavations. These diggings were continued throughout 2003, and led by Anna Gawlik and Piotr Godlewski, representing the Jagiellonian University Institute of Archaeology. Overall, the excavations encompassed around 500 m^2 of the most threatened sections of the site.

The most significant result of the diggings was the discovery of the remains of fortifications attributed to the Lusatian culture (Bronze Age). The fortifications were made of sizeable wood reinforced earthworks (Fig. 3A), surrounded by a rather shallow moat. Owing to the poor shape of the remaining structure, it is impossible to determine its original height, but it is possible that it has reached even 5 m. Traces of dwellings were also located. These came in the form of hovels and pits, and were also attributed to the Lusatian culture. Traces of long term Lusatian habitation were found not only on the spur, but also at its base. The collected artefacts consisted mostly of shards of pottery — hand shaped, without the use of the wheel — as well as of more scarce metal (mostly bronze) and bone objects. These artefacts permitted to date the Lusatian settlement of the site to the late Bronze, and the early Iron Age (1000–600 BC).

The site yielded also a medieval cemetery. The dead were not cremated, and interred in shallow rectangular grave pits, mostly without any grave goods (Fig. 3B). Based on the few retrieved artefacts (accessories and coins), the cemetery can be dated to the turn of the twelfth century AD. This is the first confirmation of the presence of medieval settlements on this site. None of the previously conducted excavations provided anything of the sort. The cemetery may possibly be connected to a nearby church or monastery, the existence of which has been supposed based on folk and historical sources.

Results of the studies conducted so far, as well as natural defensive setting may point to Witów as being a thriving settlement during the Bronze Age. Its location in the Vistula river valley may have allowed Witów to control nearby routes and possibly river fords. It also probably exercised political control over the surrounding areas.

In conclusion, it may be said that geological, archaeological and palaeobotanical locality of Witów is very important from scientific point of view. Until now, fossil macrofloras have not been found in other localities with deposits equivalent to the Witów Series. Despite the common occurrence of Neogene deposits in the area of the Małopolska Upland, fossil assemblages of macroremains of Neogene plants are very rare there. Only one fossil leaf flora from Neogene (Sarmatian) deposits from Stawiany and Młyny was thoroughly investigated (Zastawniak, 1980, 1995). Macroremains of leaves were also found at Pińczów, Busko-Zdrój and Jawor, and all of these localities have only cursory been palaeobotanically investigated (Łańcucka-Środoniowa *et al.*, 1983). Besides the listed localities of fossil leaf assemblages, there are a few reports on occurrence of carpological macroremains and fossil woods (5 localities) in the Neogene deposits in the Małopolska Upland (Łańcucka-Środoniowa, 1963). Only one of them, Morsko, lies close to Witów, two kilometres to the west.

From archaeological point of view, the Witów locality is very important as well. It must be mentioned that Witów is one

of the very few known and thoroughly studied fortified settlements of the Bronze Age in the area. These reasons make it an extremely significant site for the study of Southern Poland's prehistory. It is thus necessary to continue excavations on the whole site, and not just on its most directly threatened parts. It should be added that slopes of Vistula river valley near Witów are the habitat of numerous species of contemporary xerotermic plants (Towpasz, Kotańska, 2000).

Considering scientific value of the Witów locality and necessity of their protection, creation of natural reserve on this area is suggested.

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